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# U.H.F. planning: the degradation of existing services caused by the erection of a new mast at an existing transmitting site

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THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

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# U.H.F. PLANNING:
# THE DEGRADATION OF EXISTING SERVICES CAUSED BY THE ERECTION OF A NEW MAST AT AN EXISTING TRANSMITTING SITE

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## SUMMARY

If a new mast is erected on an existing v.h.f. transmitting site the reflexions from it will cause some degradation of existing services. The effects are summarized in this report.

## 1. INTRODUCTION

This report was originally prepared as a paper for the U.H.F. Planning Committee No. 3, and summarizes the effects on the v.h.f. television and f.m. sound services if two masts are used on the same or nearby sites. Such an arrangement may be necessary (if only temporarily) at some existing stations, in order to meet the requirements of the 1961 Stockholm Plan.

In deciding whether such an arrangement will be technically satisfactory, it is convenient to consider separately:

(i) reductions of effective radiated power (e.r.p.) caused by the presence of the new mast

(ii) the degradation due to delayed signals reflected from the new mast.

The effects caused by the presence of another mast on the performance of an existing aerial have been discussed in a Technical Memorandum.[1] This report deals only with the two aspects of the problem stated above, although considerations of cost, the difficulty of erecting two masts in close proximity, and planning permissions may well affect the final arrangement. It is assumed that:

(i) the new mast will be appreciably higher than the existing mast;

(ii) the cross section of the new mast will be about 6 ft (1·8 m) square, or a 9 ft (2·7 m) side triangle, at the height of the existing aerials;

(iii) the existing transmitting aerials are omnidirectional; with directional aerials some of the effects noted below may be either enhanced or reduced, depending on the relative orientation of the masts.

The Band II f.m. service is of course permanent; at present it appears that the 405-line service on Bands I and III may continue for at least another ten years, so it seems prudent to assess any degradations as if these services too were permanent.

Section 2 applies to transmissions on Bands I to V with any line standard. Sections 3 and 4 are concerned with the 405-line service only; the consequences of a change to the 625-line standard are considered in Section 5. Section 6 deals with the effects which would occur if the u.h.f. service were initially radiated from the existing mast.

## 2. REDUCTION OF E.R.P.

The current induced in a new mast by an existing aerial causes re-radiation which, in certain directions, is in antiphase with the direct signal, and thus reduces the e.r.p. in those directions. The e.r.p. is always reduced over an arc behind the new mast, but there are associated ripples on the horizontal radiation pattern (h.r.p.) in all directions; there are therefore reductions in the e.r.p. in some directions, with associated increases in other directions, and these may occur anywhere in the service area.

The full lines in Fig. 1 show the e.r.p. reduction for spacings of 100 - 800 ft (30 - 240 m). This reduction in the e.r.p. applies over a relatively wide arc in the backward* direction; there will be corresponding reductions, although smaller in magnitude, in the forward* direction also, shown by the dashed lines in Fig. 1.

It should be noted that e.r.p. reductions in the forward direction occur on different bearings at different frequencies. Thus, in some directions, the overall frequency response of the transmission may be subject to twice the variation shown by the dashed lines in Fig. 1. The sound/vision ratio may also be disturbed by the same amount.

If we specify that the maximum e.r.p. reduction should not exceed 1·5 dB, the minimum spacing between existing and new masts is as follows:

| | | |
|---|---|---|
| Band I | VP | 330 ft (100 m) |
| Band I | HP | 80 ft (24 m) |
| Band II | HP | 110 ft (34 m) |
| Band III | VP | 600 ft (180 m) |
| Band III | HP | 310 ft (95 m) |
| Band IV/V | HP | 530 ft (160 m) |

## 3. DELAYED SIGNALS

In addition to the e.r.p. reductions which occur with unmodulated signals and therefore affect the mean signal level, the re-radiation from the mast will also

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*The 'forward' direction is taken as that joining the new mast to the existing mast, and the 'backward' direction is opposite.

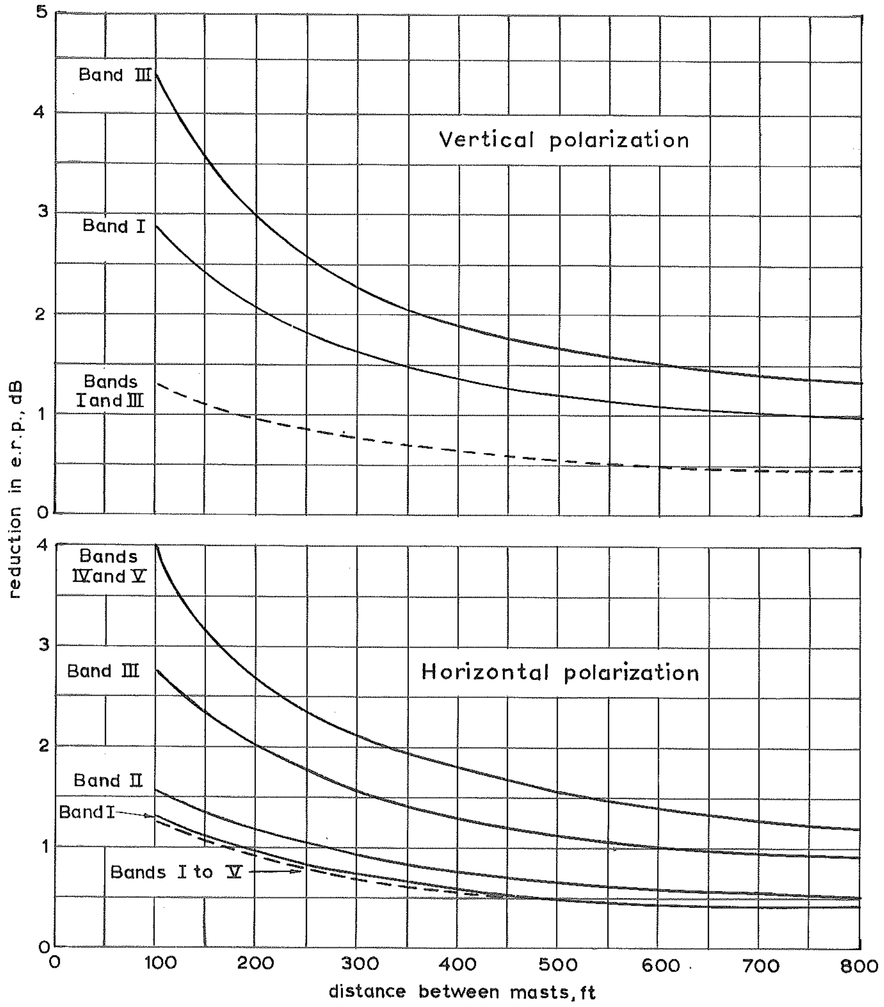

*Fig. 1 - Reduction in e.r.p.*

——— backward direction ‒ ‒ ‒ forward direction

cause delayed images to be seen on television transmissions. The subjective effect of a delayed signal will be worst in the forward direction, corresponding to the longest delay; since it will be almost as severe over a relatively wide arc centred on this direction we will consider only this condition.

The full line in Fig. 2 shows the effect of the delayed signal on the K-rating of the 405-line television system;* it applies (with only small deviations) to all bands considered, and both polarizations. A K-rating of 1% is generally regarded as the value which must not be exceeded for distortion to be imperceptible; if, however, we accept as permissible the small amount of distortion which occurs with a K-rating of 2%, the mast spacing should be either less than 80 ft (24 m) or greater than 6000 ft (1800 m). If an even greater degradation is regarded as permissible for a temporary service, say a K-rating of 4%, the 'forbidden' range might be restricted to 300 ft - 1500 ft (90 m - 460 m).

*The discontinuity in the K-rating curve of Fig. 2 is unrealistic, but it results from the present definition of K-rating.

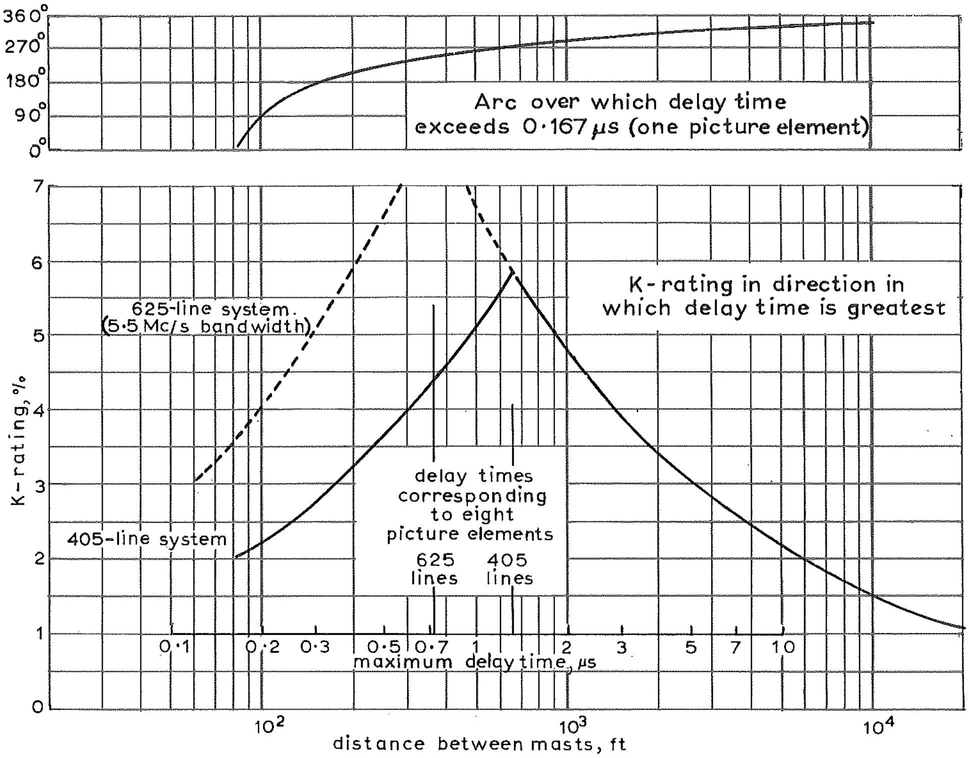

*Fig. 2 - K-rating*

This curve applies for Bands I to V, VP or HP, to a 9 ft (2·7 m) triangular or 6 ft (1·8 m) square mast

Fig. 2 also shows that the arc over which delayed images are visible increases as the spacing increases. From the point of view of delayed images, therefore, the smaller of the two distances which have a given K-rating is to be preferred.

In the case of the Band II service the level of the delayed signal is never sufficient to cause audible distortion.

## 4. RECOMMENDATIONS FOR 405-LINE TELEVISION AND BAND II SERVICES

The following recommendations take into account only the technical performance characteristics considered in this report. We deal first with individual services, and then give the overall assessment. The 'reference' condition for degradation in performance is an e.r.p. reduction of 1·5 dB and a K-rating of 2%.

### 4.1. Band I VP

This service should be transferred to the new mast. If not, we must accept a greater degradation than the reference.

### 4.2. Band I HP

There is no objection to leaving the Band I HP service on the existing mast providing the spacing between new and existing masts is approximately 80 ft (24 m). For greater or smaller spacings the degradation would exceed the reference.

### 4.3. Band II

There is no objection to leaving the Band II service on the existing mast provided the spacing between the masts is not less than 110 ft (34 m). This spacing is determined by the e.r.p. reduction specification of 1·5 dB. In view of the fact that this is a sound service, a greater reduction might be accepted, if other considerations dictate. For instance, to satisfy the requirement of Section 4.2. a spacing of 80 ft (24 m) is required; this corresponds to a Band II e.r.p. reduction of 1·7 dB.

### 4.4. Band III VP

This service should be transferred to the new mast. If we were prepared to accept a K-rating of even 4% the minimum spacing between the masts would be 1500 ft (460 m) which is tantamount to a new site.

### 4.5. Band III HP

This service could be retained on the existing mast. If we were prepared to accept a K-rating of 4%, a spacing of 300 ft (90 m) would then be required.

### 4.6. Overall Assessment

The above conclusions may be summarized as follows:

(a) The Band II service could stay on the existing mast. If this were the only service retained on the existing mast the spacing between masts should be at least 110 ft (34 m). A somewhat smaller spacing may be acceptable to accommodate the Band I HP requirements in (b) below.

(b) A horizontally polarized Band I service could stay on the existing mast provided that the spacing between masts is about 80 ft (24 m) (but only so long as the service remained on 405 lines, see Section 5). If we accept a Band II e.r.p. reduction of 1·7 dB, the Band II service also could stay.

(c) All other services should be transferred to the new mast.

(d) There will be an interim period between the erection of the new mast and the transfer of the services, when the degradation will be worse than the reference. A mast spacing of 110 ft (34 m) will result in e.r.p. reductions of 2·8 dB on Band I and 4·2 dB on Band III, and a K-rating of 2½%.

It should be emphasized that the recommendations refer to omnidirectional aerials. If advantage can be taken of the directional radiation patterns of existing aerials there will be less need to transfer services. These cases would require individual consideration taking into account the site restrictions.

## 5. V.H.F. SERVICES RE-ENGINEERED ON 625 LINES

The previous sections have considered the effect of the new mast on 405-line television services, but ultimately these will need to be re-engineered on the 625-line standard. The result on the K-rating is shown by the dashed curve of Fig. 2. The increase in K-rating for the smaller spacings means that it will then no longer be acceptable to retain a Band I horizontally polarized service on an existing mast. It is important, therefore, that the new mast be built with sufficient strength to accommodate all existing v.h.f. services, with the possible exception on technical grounds of Band II. It is, however, most undesirable to retain an existing mast merely to retain the Band II aerial. It would complicate maintenance problems and is unlikely to receive planning permission.

## 6. U.H.F. TRANSMISSIONS RADIATED FROM EXISTING MASTS

A further possibility which must be considered is that at some stations the u.h.f. services may be radiated for a period from an existing mast and later transferred to the new mast; these services would be subject to considerable degradation during the erection of the new mast. Although the reduction in e.r.p. and delayed image level will depend to a considerable extent on the structure of the new mast, i.e. on the number and disposition of its cross bracings, model measurements indicate that e.r.p. reductions up to the values shown on Fig. 1 are likely to occur; Fig. 2, however, still applies for the K-rating of delayed images. In view of the large e.r.p. reductions the aerial should be transferred to the new mast as quickly as possible.

## 7. CONCLUSIONS

In the light of the considerations stated in this report it is recommended that where a new mast is provided it should be designed to radiate transmissions for all services. In addition, to avoid degradation of the existing services for a long period, the 405-line television and Band II sound aerials should be transferred to the new mast as soon as is practicable, even though the 405-line service aerial may later be superseded by a new 625-line service aerial. U.H.F. services radiated from the existing mast should also be transferred as soon as possible.

The spacing of the new mast from the existing mast involves a compromise between e.r.p. reduction and reflected signal level. A tentative proposal is that the new mast should be spaced at about 100 ft (30 m) from the existing mast, provided site considerations permit. For this arrangement the K-rating (2-3%) and the e.r.p. reduction (not more than 3 dB on Band I, 1·5 dB on Band II, not more than 4·5 dB on Band III, and not more than 4 dB on Bands IV/V) may be regarded as acceptable for a short interim period. If the e.r.p. reductions are considered excessive a greater spacing should be used, but this would be at the expense of an increase in the K-rating.

There are certain cases where, on technical grounds, it will be possible to relax the requirements either by adopting a greater spacing between the masts, or by leaving existing aerials on an existing mast for a longer time. The latter course, with a spacing between masts of 100 ft (30 m), may be adopted with omnidirectional horizontally polarized Band I aerials, and with Band II aerials. A spacing of 100 ft (30 m) may also be used if the existing aerial (Band I, II or III, HP or VP) has a directional h.r.p., provided advantage can be taken of the directional pattern in siting the new mast. If in particular cases it is desired to take advantage of such relaxations these should be examined on an individual basis before finalizing the proposal.

## 8. REFERENCE

1. 'Reflexions from Masts at Very High Frequencies', Research Department Technical Memorandum No. E-1065, December 1961.

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